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THE LESIONS OF CHOLERA.

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A REPORT

FOUNDED ON TWO CASES,

BY

I. N. DANFORTH, M. D.,

Lecturer on Pathology in Rush Medical College, Chicago.

REPRINTED FROM THE REPORT OF THE BOARD OF HEALTH OF THE CITY OF CHICAGO, FOR 1874.

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THE LESIONS OF CHOLERA.

CASE I.

The clinical history of this case is provokingly meagre and deficient, especially when the fact is taken into consideration that the patient died in a public hospital, subject to the disciplinary regulations thereof. The brief notes before me were furnished by Dr. Hyde. From them I am able to record the following: The patient (I am not informed whether male or female) was admitted to the Cholera Hospital August 26th, 1873; was married three weeks previously; had cicatrices of buboes and syphilides on the cutaneous surface, and an ulcer over the internal aspect of the left thigh which was probably syphilitic. The prominent symptoms of epidemic cholera were pronounced, namely, "vomiting, purging, cramps, cold breath and rice-water discharges." I infer that collapse came on soon after the patient's admission, as I learn from Dr. Hyde's notes that milk was injected into the veins on the night of the 26th, or shortly after admission. Death occurred on the following day (August 27th), and the necropsy was made by Dr. Wood on the evening of the 27th, between the hours of eight and eleven. Concerning the post mortem appearances, I have exactly no information at all; the notes in my possession do not so much as indicate the sex of the patient. Dr. Hyde, however, was kind enough to send me the following specimens:

(1.) Termination of ileum, and commencement of colon.

(2.) The lower 6 inches of the ileum, empty.

(3.) Section of the ileum, about six inches long from its central portion, with its contents imprisoned in the intestine by ligatures applied previous to removal.

(4.) Portion of mesentery 18 inches from ileo-cæcal valve.

As no pathological appearances are recorded in connection with the remaining organs of the body, it is fair to presume that they were all in healthy condition. Of course my own observations must be confined to the specimens enumerated above.

(1.) *Termination of ileum; that is, that portion of the canal immediately above the commencement of the colon.* The mucous membrane looked swollen, soft, of a peculiar ashy hue in some spots, unusually pale or blanched in other spots and unnaturally red in still other places. Hence the surface of the membrane presents a singularly mottled or "speckled" appearance. An enormous number of elevated papules, each the size of a pin's head, may be both felt and seen. If the specimen be gently put upon the stretch and held between the eye and a strong light, groups of arborescent or stellate vessels may be seen which are not apparent in health. Under a hand glass of moderate power, numerous minute vessels, turgid with blood, some of them tortuous and elongated, are brought into view; but it may also be observed that the inter-vascular spaces are unusually pale and translucent. The elevations or papules alluded to above are also brought more prominently into view and are seen to be quite symmetrically arranged, thus indicating their origin in swollen Peyers or solitary glands. If the finger be passed gently over the mucous surface, the minute elevations, consequent upon the swelling of these glands, can be readily felt, as well as a peculiarly soft, delicate, velvety feeling, which I do not remember to have seen described.

Microscopy.—Before detailing the morbid microscopic appearances, it will be expedient to recall the structure of the intestinal canal in health, that we may have some reliable standard for comparison. A transverse (vertical) section of healthy small intestine, well prepared and mounted, presents the following appearances: two well defined compact layers, namely; a mucous layer and muscular layer; between these, a loose network of areolar tissue (the so called sub-mucous connective tissue,) which binds the two layers together, and also serves as a support to the vessels in their passage towards the mucous membrane; in connection with, sometimes imbedded within, sometimes projecting slightly below, the mucous layer, we find Peyers glands (the so called agminate glands) huddled together in "schools" or patches, and the solitary glands, which are slightly larger than the former, but precisely similar in structure. In addition to this, we find those peculiar projections of mucous membrane, called "villi," which float their free extremities in the lumen of the intestine, for the purpose of absorbing by virtue of their epithelial structure, the nutrient material within their reach. The villi as well as the floor of the intestine, are coated with a compound layer of conoidal epithelium, which can readily be seen with a quarter inch objective. [Fig. 1.]

We are now prepared to appreciate the changes found in our choleraic specimens. I have examined several sections cut from the specimens above described. Under a power of about 80 diameters, the following appearances are noted: the mucous and muscular layers seem to have been much disturbed in their relations, and separated widely apart; between them a very beautiful, loosely woven, web of areolar or connective tissue is seen, sending its delicate filiaments across the intervening space, with here and there a little vessel, making its way towards the mucous layer; the latter is unusually thin, and unusually smooth on its free surface; not a single perfect villus can be seen, but a few "stumps" of villi are easily made out, as though the missing portion had been rudely torn away. Under a power of 260, the surface of the mucous layer is seen to be almost, in fact *quite* denuded of epithelium, since not a single normal club-shaped cell can be seen. The mucous membrane seems to have passed through some scene of violence, during which its villi have been wrenched from their attachments, and its clothing of epithelium stripped from its surface and carried away. It seems almost beyond belief that a few short hours could have so totally changed the intestinal surface, but every section which I have examined from the specimen of intestine, now under consideration, presents precisely the same appearances. Peyers glands do not seem to be much altered, quite to my surprise. Possibly they are slightly swollen, but not otherwise perceptibly altered. But, after all, this is not so surprising; the storm is too brief to affect tissues beneath the surface to any great extent. It is rather like a terrible tornado, desolating everything within its reach, but limited in its ravages to objects presenting salient points of attack. The sub-mucous connective tissue, and the muscular layer are both beautifully displayed, but neither present any evidence of disease, unless the unusual separation of the mucous and muscular layers be regarded as such. [Fig. 2.]

(2.) *Commencement of the colon; that is, that portion immediately below the ileo-cæcal valve.* With the exception of an unusual turgidity of the smaller vessels, no abnormal appearances were detected by the unaided eye. Nor does the microscope disclose anything in respect to the mucous membrane of the colon, which could be classed as peculiar or distinctively abnormal, save the loss of its epithelium, as in the case of the specimen last described. The same singular tendency to separation from the muscular layer, upon the slightest pressure, is also to be noticed in the specimen now under consideration, and, of course, the same elegant display of intervening connective tissue.

(3.) *Portion of the ileum, about six inches above its termination in the colon.* To the unaided eye, the mucous membrane seems a little swollen ; it is quite pale, and presents the same papulated appearance, alluded to in connection with specimen No. 1 ; numerous stellate groups of turgid vessels are easily seen, and it is also observed that they sometimes appear irregularly distended and tortuous, with knob-like enlargements or protrusions here and there, as though they had been suddenly and forcibly injected with blood, and had, as a consequence thereof, suffered forcible rupture of their inner tunics, in certain localities.(1) To the touch the mucous surface seems soft, velvety, and water-soaked, or *sodden*, as though it had long been macerated in tepid water.

Microscopy.—Under the microscope, this specimen looks much more natural, and appears to have suffered much less violence than the one first examined. A power of 80 diameters shows the mucous and muscular strata sustaining their normal relations to each other; both layers, with the interconnective tissue are handsomely shown, as well as the lumina of the over-distended vessels. Confining our attention to the mucous layer, we find that its free surface gives evidence of having passed through some violent convulsion, and of having sustained serious injury thereby. Most of the villi are gone; their ragged proximal ends or points of attachment are still seen, broken and torn, like the stumps that mark the course of the recent cyclone: some of them are half gone, leaving behind the proximal half, more or less damaged; a few remain apparently intact, but *only* apparently, as we shall shortly see. Peyers glands, and the solitary glands are enlarged, swollen and filled with a confused mass of cells, probably the half-grown epithelium, violently hurried from its legitimate home. It now becomes evident that the little elevations or papules already referred to, are the swollen and distended solitary glands.

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(1) I regret that the specimen presenting these peculiar appearances could not be permanently preserved, with its morbid anatomy, but that, of course, is impossible.

Under a power of 260 diameters, the ragged remains of numerous villi are seen with great distinctness, and those which are apparently perfect, are now seen to be shriveled and contracted, and also to be totally stripped of their characteristic epithelial covering. The shriveling of the villi is so great as to quite change their appearance, and suggest atrophy in marked degree. Of course some allowance must be made for the altered size of the villi, on account of the absence of the conoidal epithelium, but after making all possible allowance for that, the shriveling is yet undeniably great. The free surface of the mucous membrane is entirely deprived of its usual epithelial coating, in place of which we see an irregular layer of small round cells, which are doubtless the progenitors of the future perfect epithelial cells; in other words, the upper, exposed and full grown layer is gone, having been hurried away in the general uprooting of the epithelial structure: the lower layer still remains, and had the patient recovered, would soon have developed into a perfect conoidal epithelial coating, in accordance with its own law of type. Under the higher power, the huddled mass of cells, which, in some instances, completely fill the solitary glands, shows with greater distinctness, but the cells themselves present nothing requiring extended remarks. [Fig. 3.]

(4.) *Specimen of the ileum, with its contents retained by ligatures, from the middle third of the canal.* The Intestine. The intestinal wall is excessively thin, and the inter-vascular spaces quite diaphanous; the vessels are intensely congested; the solitary glands are swollen and elevated above the surface; no ulceration.

Microscopy. A low power (80 diameters) shows that the mucous layer is surprisingly thin, and that the slight pressure of the glass cover is sufficient to produce a wide separation between the mucous and muscular layers, thus displaying the areolar tissue and vessels intervening; the villi are mostly present but much shriveled and contracted, and in some instances torn. Increasing the power to 260 diameters we are able to see that, although the villi are pinched and shriveled, they are not, like those already examined, entirely deprived of epithelium, but that they are generally clothed with a single dense layer of small round or polygonal cells, and that a true conoidal cell may occasionally be seen. But this layer of polygonal cells must not be mistaken for the true epithelium, which consists always of conoidal or club shaped cells, and these, as I have just stated, are only occasionally seen. The upper layer of true conoidal cells is missing; the lower layer of cells, which would be conoidal if let alone, is still in place, and, in the event of the patient's recovery, would have been developed into typical conoidal epithelial cells. The floor of the intestine is also covered with a layer of similar cells; the exceeding thinness of the mucous membrane is still apparent, but nothing like ulceration, or localized loss of substance or solution of continuity is apparent. [Fig. 4.]

(5.) *Microscopy of the Intestinal Contents.*—It will be remembered that the specimen now under consideration was sent to me with its contents retained by ligatures The ligatures were removed immediately upon receiving the specimen, and the contained liquid allowed to flow into a conical glass. It was thin, watery, dirty clay or ash color, and in a short time separated into two parts—a dense grayish deposit, and a clear watery fluid. A drop of the deposit magnified 260 times, as seen to consist mainly of cells, but partly of granular matter in rather coarse granules. Concerning the cells I find: (1.) single full grown and quite perfect conoidal cells scattered here and there in disorderly groups; and these, it seems to me, are the few remaining cells of those which clothed the villi and coated the floor of the intestine at the commencement of the attack. These worn-out and cast-off conoidal cells are generally present in great number in the intestinal canal; in this present instance the majority of them had been carried away by the earlier discharges but a few still remained, probably by lodging in the corrugations of the intestinal mucous membrane. (2.) Large patches of cells, nearly or quite full grown, which formed the first layer of cohering cells, composing the epithelium of the villi. By "cohering cells," I mean cells so joined together by their peripheries as to adhere with sufficient tenacity to admit of being torn away from the villi, and probably carried out of the intestinal canal, without very much disturbing their relations to each other. (3.) Smaller and more symmetrical, as well as more intimately united patches of cells, which are obviously the deeper layer of epithelial cells from the villi. These are half grown cells, hurried off while yet in their childhood, and therefore prior to their having entered upon their functional life. While it is well known that the intestinal epithelium, like that of all other parts of the body, is being constantly thrown off in the form of individual worn out cells, it is also equally well known that patches of cohering cells are *never* found free in the intestinal canal, except in conditions of grave and generally acute and, indeed, violent disease. In chronic intestinal diseases, a few cohering cells from the upper layer, usually in a granular or fat-bearing condition may occasionally be found; but when large patches of still adherent cells, from the lower as well as the upper layer, are thickly scattered over the field of the microscope, we may confidently predict that the patient is in a condition desperate indeed, if not necessarily fatal. For it indicates the flooding of the intestinal canal by the most violent exosmotic action; a condition of things which, when not produced by local irritants, or the most drastic cathartics, speaks of the invasion of the system by a profound "zymotic" poison. (4.) I also find an occasional isolated nucleated cell, which has every appearance of being a white blood corpuscle. Such I believe it is. In view of the well-established fact that these cells, under conditions of intense excitement, speedily become migratory in their habits, I think it is altogether probable that many of them acquire the power of ameboid movement, and, being aided somewhat by the outflowing current of serum, escape from the vessels and make their appearance in the intestinal canal. In the latter stages of cholera this supposition becomes almost a certainty. For, in the first place, the villi have been stripped of their natural clothing of epithelium, which brings the capillaries almost to the surface—in some places, probably, they are quite exposed; in the next place, collapse is by this time fully established, and, if the exosmotic action is now less violent, the profound relaxation of tissue—especially of contractile tissue—produces the precise condition most favorable for migration of the corpuscles;* lastly the corpuscles themselves are by this time in the "ameboid" state, and are therefore ready to take advantage of the conditions which favor their escape. The presence of the white corpuscles in the intestinal canal, therefore, is not a matter to be wondered at; it is merely the inevitable result of the operation of established laws of pathology. As the specimen of mesentery, before alluded to, presented nothing abnormal, no remarks concerning it will be necessary. (Figs. 5 and 6.)

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* I have often observed that migration of the white corpuscles takes place in the frog with great promptitude and certainty, when the animal is profoundly under the influence of woorara; that is, where extreme relaxation is produced. The woorarized frog may be looked upon as physically in a condition of extreme collapse; in both cholera patient and frog, a terrible poison has been administered to the nervous system.

CASE II.

The patient, Joseph Schere, was admitted to St. Luke's Hospital, on the 7th of September, 1873, with well pronounced symptoms of cholera. Shortly after, he was sent to the Cholera Hospital, and from the time of his admission there, came under the notice of Dr. J. N. Hyde, who furnished me the clinical history, so far as he could obtain it, and notes of a post mortem examination, made by himself. I cannot do better than insert Dr. Hyde's account of the case at length, which is as follows:

"The patient, an Alsatian, had been admitted from St. Luke's Hospital to the Cholera Hospital, Chicago, on the 7th of September, 1873. When examined, almost immediately after admission, he was discovered to be in a condition of collapse, but was still vomiting and purging freely. The emesis was checked by the administration of a solution of carbolic acid (gr. i ad oz i.); the purging however continued in spite of the medication pursued, which consisted chiefly of stimulants and the administration of beef tea. Soon after the exhibition of the latter the stools lost their "rice-water" characteristics, and consisted largely of the undigested and unabsorbed nourishment given. The patient exhibited the "facies choleraica," had a coolness of the expired air which was very noticeable, and suffered from cramps. Specimens of twelve of his dejections were preserved for examination in separate bottles, and numbered in the order of their occurrence. The entire surface of the body had been cool and damp, the lips, tongue and cutaneous superficies were livid; there had been also extreme restlessness, thirst, feeble, rapid pulse, dyspnoea, complete suppression of urine, sunken countenance, mental apathy, half opened eye lids, and a partial recognition of his condition; consciousness continued up to within a half hour of his death, which occurred twenty-three hours after his admission. The patient died in great agony, and was so violent that the attendants were obliged to hold him forcibly in bed. This was all of the previous history of the patient I could gather from the officials of the Hospital. The patient was said to have been exposed to the disease in the state of Indiana."

"*Necroscopy* at 10 A. M. of September 9. Rigor-mortis was fully established. The body appeared to be that of a man not far from thirty-five years of age, somewhat emaciated. The skin of the face and neck was exceedingly dark, that of the abdomen and lower limbs of a natural color. The eyes were sunken, the abdomen not depressed and resonant on percussion. The dura mater and pia mater of the brain were deeply congested and the sinuses of the brain were filled with fluid, dark red blood. The hemispheres, on section, presented an enormous number of "puncta cruenta," and the floors of the lateral ventricles, the velum interpositum, the pes hippocampi, and the valve of Vieussens, were all equally injected; a similar condition was found over the entire surface of the base of the brain, the surface of the cerebellum, the pons varolii and the medulla oblongata. The arachnoid membrane everywhere was translucent and normal. No evidences of pathological products were anywhere visible. The lungs were of a dark slate color, and in their posterior portions, were deeply congested. They were everywhere crepitant on pressure, and were neither solidified nor bound down by pleuritic adhesions."

"The heart was large, firm and filled with fluid, dark, almost black blood. Firm, white heart-clots were found in each ventricle, well attached to the tendonous columns of the valves. The latter were of normal appearance. The right side of the heart was more fully expanded by dark blood than the left, but it was not evident that the left was entirely empty. The liver was of a normal size, of a dark purple hue, and a section appeared to be gorged with venous blood. The gall-bladder was moderately distended, and its mucous lining smeared with a dark tenacious and tarry bile. The spleen was enlarged to, at least, twice its normal size and was deeply congested, almost black on section. The kidneys were of natural size and color externally, but were also, on section, found to be congested and of a darker color than was normal. The apices of the pyramids were particularly engorged. The bladder was contracted fully and completely. It did not contain, as far as could be ascertained, a single drop of urine. Its mucous lining was entirely normal in external appearance, and presented no traces of the congestion so marked in the other viscera. The stomach was distended with fluid contents, consisting largely of beef tea, and was not manifestly altered. The entire intestinal tract was moderately distended with fluid contents, of offensive, but not excessively offensive odor, of the consistency and color of reddish pea-soup. The external surface of the intestines presented a color very peculiar, suggestive of a light chocolate, a tan and yellow combination; and this was true of every portion of the tract, but especially of the small intestines. The rectum was merely smeared with a reddish-yellow secretion, not sufficient to constitute "contents." The pancreas was unaltered, the mesenteric vessels injected; the omentum diaphanous and normal; the peritoneal membrane, abdominal glands, prostrate, glands of Cowper, cerebro-spinal nerves, ureters, larger arteries and supra-renal capsules all appeared in a normal condition. No pericardial fluid was discovered."

"The following specimens were preserved for microscopic examination:

Section of right hemisphere of brain; floor of lateral ventricle; pons varolii and medulla oblongata; left and right heart-clots; sections of liver, spleen and both kidneys; ilio-cæcal section; portion of central tract of ileum (the latter with contents undisturbed); bladder entire with attached prostate, and a portion of the walls of the gall-bladder. The muscular tissue was normally red and firm. Description of the mucous lining of the intestinal tract to be found in the report on the specimens preserved."

Upon microscopic examination of the specimens of the various parts and organs sent to me, I found nothing, except evidences of recent congestion, save in the specimens of intestine; to those, and to the microscopic appearances of the alvine discharges, therefore, our attention may be limited. The intestinal specimens consist of the middle third of the ileum, the lower extremity of the same, and the upper extremity of the colon.

(*a*). *The central portion of the ileum under a low power.*—It is evident that the mucous lining of the intestinal canal has undergone great and violent alterations. The appearances do not vary greatly, except in degree, from those observed in connection with Case I. The villi are nearly all torn away, and the remaining stumps present a rather ragged appearance. The solitary glands cannot be recognized; the disposition to separate from the muscular layer is much less than in the former specimens; the connective and muscular tissues seem quite normal. Under a higher power (260 diameters) patches of shriveled Peyer's glands are seen; the damaged condition of the villi is more apparent and the mucous membrane appears to have been nearly stripped of epithelium.

(*b*) *Ileum, near ileo-cæcal valve.*—In this location the villi seem to be almost destroyed; Peyer's glands are scarcely recognizable; the mucous membrane shows hardly a trace of epithelium, and in fact the intestine, in its entire structure is so changed that an expert might be pardoned for failing to recognize it.

(*c*.) *Colon near ileo-cæcal valve.*—This specimen does not show any very material change. In fact, with the exception of a somewhat shriveled and pinched appearance, and the loss of the upper stratum of its epithelial coating, there is nothing about it worthy of mention.

Microscopy of the choleraic discharges.—I received from Dr. Hyde eleven bottles containing specimens of the dejections, numbered from one to eleven, in the order of their occurrence. I am not informed at what stage of the disease the first discharge occurred, or how long before death the last one took place. As, subsequent to the passage of the first two or three specimens, the patient was assiduously plied with beef tea, the greater portion of which was unabsorbed, the microscopic appearances are largely modified and masked, and their value correspondingly lessened thereby. Specimen No. 1.—A great amount of granular matter was present, in the form of very large oblong masses, of a light gray or ash color. On being gently compressed by the covering glass these masses separate into smaller masses, and, if the pressure be still increased, these secondary masses are separable into very minute granules, which are probably composed of albuminous matter, derived from the blood. I also observed occasional oblong patches of small round or polygonal cells, probably epithelial cells, thrown off from the villi and floor of the intestinal canal; and, scattered here and there, an occasional full grown epithelial cell, not yet carried out of the intestine, but looking cloudy and nebulous, as though it had been for some time macerated in the intestinal contents. Specimen No. 2.—About the same appearances, with the addition of a few free oil globules. Specimen No. 3.—The sediment consists largely of oil globules and floating masses of granular matter; an occasional patch of aborted epithelial cells may be seen, but they are less abundant than in preceding specimens. Specimens Nos. 4 to 11.—The appearances are chiefly marked by the presence of extraneous matter, derived from the beef tea, of which the patient partook frequently during the last hours of his life. I find shreds of striated muscular fibre; bits of connective tissue; crystals of sodium chloride and potassium chloride; fat globules; a few epithelial cells; masses of granular matter; bits of vegetable structure, which I apprehend are fragments of tea leaves; and some other bodies which I cannot recognize, but which I believe to be altered blood corpuscles. It is obvious that these latter specimens, however interesting they may be from the standpoint of microscopy, throw very little light on the pathology of cholera. Examined with a high power (about 1000 diameters) I could discover no special or peculiar structure which could be called a specific cholera germ, in any of the specimens of intestinal discharges, but myriads of granules, far more minute than those already alluded to were brought into view; and I have no doubt that a yet higher power would have revealed other granules smaller still.

Having now completed the examination and description of the specimens furnished me, I propose in conclusion, to offer a few suggestions on the subject of contagion, since the resolution of this society,* under which I am acting, called for "special reference" to this matter. The patients from whom my specimens were obtained, both came from infected districts lying south of us, just prior to being attacked themselves. In what form did they obtain the poison and how did they transport it hither? I think the microscopic revelations of the last few years, especially since the introduction of very high powers by Beale and others, are sufficient to warrant us in believing that all developmental or reproductive power resides in that portion of the cell which, following Brown, *we* call the "nucleus," but which Beale has very aptly named the "germinal matter," because it *is* the *germinal* matter; that this germinal matter multiplies with wonderful rapidity, and, in the majority of instances, by the process of "budding" or "gemmation"; that in its living state, germinal matter is not enclsoed in a cell wall or closed sac, but is merely a little mass of soft gelatinous matter, wholly unconfined by any membranous envelope, and that it frequently exists in particles quite too minute to be seen by the highest magnifying powers at our command. But this is not all. The lowest forms of living matter are known to multiply with far greater rapidity, and to retain life with far greater tenacity than the higher forms; numerous examples illustrating these statements could be adduced did time permit. The experiments of Prof. Tyndall and others, seem to indicate clearly enough that the lowest and most minute germs may be completely dessicated and blown about by currents of air, and yet retain their power of growth and multiplication; in other words, retain the principle of life. With these facts before us, it is easy enough to *reason* with some degree of intelligence and probability, not upon the *nature* of the cholera contagium, but as to the manner of its preservation and transportation. In all probability the blood is the primary seat of attack in every case of genuine cholera; at all events is very soon and very profoundly affected. Next in order, we have the choleraic discharges, and whether these discharges be "eliminative" or not, they take place with frightful rapidity, and they must be derived mainly from the blood by violent exosmotic action. In the next place, thoughtless and frightened attendants are *almost* certain to throw the dejections into defective drains, or into exposed cess-pools, or upon the ground in some secluded spot, where they are least likely to attract attention and most likely to do subsequent harm. But, with the greatest and most intelligent care, it is impossible to avoid soiling the floor or carpet or bedclothes or all three, and, with the most assiduous use of disinfectants, it is equally impossible to secure *absolute* protection from the harmfulness of the discharges, if they possess the power to harm. As a plain matter of fact, we all know from practical experience that generally, hands, wearing apparel, bedclothes, carpets, furniture, each and all are more or less stained and soiled by the discharges, in the hurry and fright and excitement of administering to the many and urgent wants of a cholera patient; and precisely the same insane fright causes attendants to be neglectful of the proper use of disinfectants. Referring once more to the microscopy of the discharges, it will be remembered that numerous exceedingly minute granules were found to be present. Now these same granules, which our highest powers reveal, together with a presumably larger number which our highest powers do *not* reveal, are constantly escaping from the bowels; are constantly being exposed to the sun's rays, to the air of heated rooms, and to moving currents of air, which dessicate them, and then waft them in all directions; are constantly entering the mouths, noses and lungs of those who are compelled to breathe the infected air, and also constantly falling upon our food, and into our drinks, and being carried thence to our stomachs. From a mucous surface, the way into the blood is direct and easy, and, once in the blood, these minute germs find an abundance of their most appropriate pabulum, and are therefore under the best possible conditions for rapid multiplication. But it is not necessary that the contagium particles themselves should enter the blood; it is not even necessary that they should *all* be living; indeed, it seems to me more than probable that the great majority of those that enter the stomach must undergo solution before entering the blood. But, granting that they are liquefied and then absorbed, it does not follow that the poisonous principle is annihilated or rendered harmless. This view of the mode of propagation and transportation of the cholera-poison is strengthened by analogy. According to Beale, the cattle plague, or "Rinderpest," which ravaged the cattle-herds of England, a few years ago, and which was investigated by a Board of Commissioners, was propagated by exceedingly minute living germs, which were conveyed from herd to herd by some one of the modes of transit above mentioned. The fluid of the vaccine vesicle is now known to contain very minute granules, upon which the specific properties depend; and our own Bartlett has lately shown us how paludal fevers may be propagated by minute spores. Finally, professional opinion everywhere is gravitating towards the "germ theory," because that theory, better than any other, explains the frequently rapid spread of the so-called zymotic diseases, as well as the peculiarities which we sometimes meet with in their manner of traveling from place to place.

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* The Chicago Society of Physicians and Surgeons.

The great length to which this paper has already reached, is a sufficient apology for closing abruptly, without any allusion to the opinions of standard writers upon the subject of cholera.

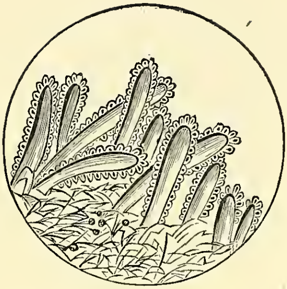

FIG. 1.

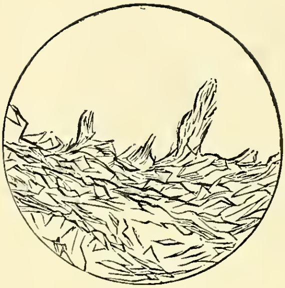

FIG. 2.

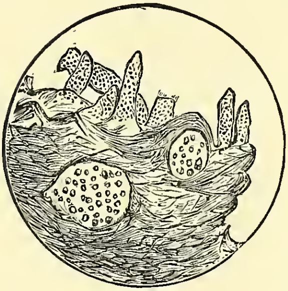

FIG. 3.

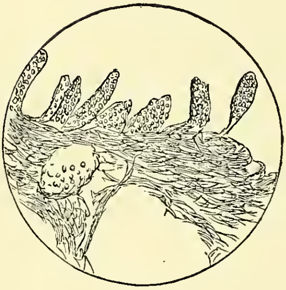

FIG. 4.

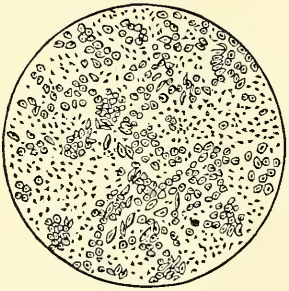

FIG. 5.

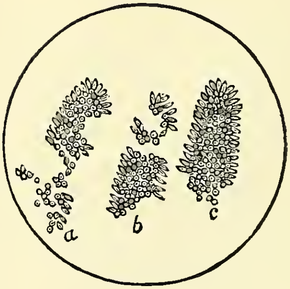

FIG. 6.

EXPLANATION OF PLATES.

FIG. 1. *Shows the appearancs of the villi in health, during the period of quiescence; that is, during the intervals of digestion.*—The outlines of the several villi shown in the figure were drawn from nature, the specimen having been prepared by the writer. The deep layers of epithelial cells, that is, the young or half-grown cells, have been omitted, as well as the blood vessels and lacteals. My object in introducing this figure is to illustrate what the microscope shows when a specimen of healthy villi is examined in the fresh state, before being subjected to any special preparatory process. The villi only are shown.

FIG. 2. *Section of the ileum immediately above the ileo-caecal valve.*—The figure represents, in a very accurate manner, the actual appearances presented by the specimen itself. The villi seem not only to have been robbed of their epithelial coating, but to have suffered violence themselves; as I have remarked elsewhere, "not a single perfect villus can be seen," and although I examined half a dozen sections from the same specimen, I found not a perfect villus in the whole. The torn, ragged appearance represented in the figure is by no means an exaggeration, but is as much like the actual specimen as a drawing can be.

FIG. 3. *Section of the ileum, about six inches above the ileo-caecal valve*—This specimen shows the villi shrivelled, contracted and quite destitute of fully developed epithelial cells. The cells remaining are those, or a portion of those, composing the deep layer. The full-grown club-shaped cells are no longer present, having been hurried off in the earlier stage of the attack. The pinched or shrivelled appearance of the villi is well shown. A couple of Peyer's glands are also shown filled with a disorderly mass of cells.

FIG. 4. *Section of the middle third of the ileum.*—In this specimen the villi and mucous membrane have sustained less damage than those just described. The villi have lost their usual coating of club-shaped cells, but they are not much damaged otherwise; the shrivelling is notably less. The deep or growing layer of epithelial cells is still in its proper place.

FIG. 5. *The intestinal contents.*—A variety of cells are shown in this figure, some of them detached and isolated, others in patches or groups. It is intended to illustrate the fact stated in the text, that fully developed conoidal cells, half-grown

conoidal cells, white blood corpuscles and altered red blood corpuscles, as well as multitudes of minute granules, are to be found in the later choleraic discharges. The figure is not quite satisfactory, but perhaps accomplishes as much as can be expected in a black and white wood cut.

Fig. 6. This figure shows, in a very perfect and beautiful manner, the actual appearance of the patches of "cohering cells" under the microscope. The right hand figure (*a*) shows the cell covering of a villus, but considerably broken and torn, especially at the lower part. The central figure (*b*) shows the same disturbance of the cells at the free extremity, while the left hand figure (*c*) shows very perfectly the entire cell covering of a villus, which seems to have been "pulled off" as one pulls off his glove finger. I found very many specimens quite as perfect as this; in most cases, however, the cells were somewhat disturbed, possibly by the pressure of the covering glass, although I was exceedingly careful in its application. The specimens in the last two figures, it must be remembered, were received in the intestines, as stated in the text. Such perfect epithelial casts of the villi could hardly be looked for in the choleraic discharges. The power employed in making these illustrations was about 260 diameters. In the first four figures I have only attempted to show the villi, because the lesions were mainly limited to the villi.

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